# WORKING DRAFT

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Interim User's Guide for

the Oil Module

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## Introduction

This report serves as a user's manual for the oil module in its present form. Earlier Project papers (especially Research Report No. 15) have described the oil industry as it might be seen by a producing-country decision-maker. Certain aspects of the simulation module have been revised in order to reflect structural changes in country-company relationships that have occurred in the last six to nine months, but in general the context in which the module functions is accurately discussed in those papers. It will be assumed throughout the remainder of this paper that the reader is familiar with the earlier material.

The next section of this report will discuss the mechanics of how the user communicates with the module. Following that is a brief summary of the module's current structure and the relationship of that structure to the changes in country-company relations mentioned earlier. Then a treatment of the commands necessary to run the model will precede a description of a sample run of the module. In this sample run, an attempt is made to simulate the recent embargo and its aftermath (from the standpoint of Saudi Arabia).

## Communicating with the Module

As mentioned in earlier Project reports, the oil module is eventually intended to send information to, and receive control from, a decision-module which will simulate the actions of decision-makers in the producing country. When the oil module becomes linked with the decision-module, the user will not communicate directly with the oil module; all communications will be handled by either the decision module or a higher level user interface module especially designed to perform input-output functions. Accordingly, some interim arrangement is necessary to facilitate user communication with the

module during the present stage of development and testing.

The PL/I language in which the oil module is written contains a feature which accomplishes this interim communications task with a minimum of input-output programming. The feature is the GET DATA statement for input, and the statement functions rather straightforwardly.

The module will notify the user that information may be entered by prompting the user in two ways. First, a short message will be printed at the user's terminal. This message will identify to the user what information may be entered at this particular time. Immediately below the message will appear a colon (occasionally a short delay will occur after the message and before the colon is printed). After the colon has been printed the user may enter information.

The format in which the information is entered is <u>critical</u> but simple. If one wished to set a variable (say PP, ∿ posted price) equal to some value (say $2.50), one would type the following (called an <u>assignment</u>):

PP=2.50

Notice that no blanks appear within the assignment. Blanks may appear before an assignment, but <u>not</u> within one. If one wished to set a second variable (say DPIR, or desired production increase rate) to some value (say 200,000), then one would type another assignment, either on the same line as the preceding one or on the following line. If the second assignment were typed on the same line as the first it would look like this:

PP=2.50  DPIR=200000

One or more blanks must appear <u>between</u> assignments on the same line. If the second assignment were to be typed on the line following the first, then it would look like this:

PP=2.50    (cr)

DPIR=200000

NOTE:  (cr) signifies that the user pushes the carriage return key.


In general, the user may type as many assignments as may be appropriate using either or both of the methods just described.  For instance, we might have:

PP=2.50   DPIR=200000   COCI=300

Or we might have:

PP=2.50   DPIR=200000  (cr)

COCI=300

Or finally we could have:

PP=2.50  (cr)

DPIR=200000  (cr)

COCI=300

When the user has entered all the assignments he wishes, he then enters a _semicolon_ and pushes the carriage return.  The semicolon signals to the module that no more assignments are to be made and that it should return to normal processing.  If the user does not wish to make _any_ assignments at the time of the prompt, he should enter a semicolon and press the carriage return after the colon appears.  Thus our examples would look like this:

:

PP=2.50   DPIR=200000   COCI=300;  (cr)

Or

:

PP=2.50   DPIR=200000  (cr)

COCI=300;  (cr)


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Or

:

PP=2.50 (cr)

DPIR=200000 (cr)

COCI=300; (cr)

When entering information, keep in mind the following points.

1.  Decimal points should be included (if appropriate) in an
    assignment.

2.  Commas should <u>not</u> be included in an assignment (i.e., DPIR=200000,
    <u>not</u> DPIR=200,000).  This is so even though commas are included
    when the values of many variables are printed by the module as
    output.

3.  No blanks may appear within an assignment.

4.  At least 1 blank must appear between assignments which appear
    on one line.

5.  An assignment may <u>not</u> be continued from one line to the next;
    if the user cannot complete an assignment statement before the
    end of the present line, he should backspace until he gets to
    the blank(s) at the end of the last complete assignment and then
    press carriage return, typing the deleted assignment on the next
    line.

6.  Once the user has pressed carriage return, whether after a
    semicolon or not, the line entered may not be changed.  Check
    to see that all assignments on a line are correct before pressing
    the carriage return.  (Remember that errors on a given line
    may be corrected by backspacing.)

7. Occasionally one may wish to enter an assignment for a variable which has letters (instead of numbers) to the right of the equals sign. This is done by enclosing the value in apostrophes and by typing the letters in upper case. Example:

CONTROL='STOP'

The user need not be concerned with the manner in which variable values are printed by the module as output. It should be noted, however, that occasionally a variable value printed as output will be printed with a semicolon following. This is of no importance and should be ignored.

This completes the discussion of user communication with the oil module. Further information concerning specific prompting messages and appropriate user responses will be found in section IV.

## Current Structure of Module

As pointed out earlier, the oil module has undergone modification, mainly because of events in the last six to nine months. In its present form, the module has three stages. The first stage generates country revenue from oil for the years 1963 through 1972. It determines the monthly revenue for any given month of that period by taking one-twelfth of the country's revenue for the appropriate year. The annual revenue figures are taken directly from Table 95 (for Saudi Arabia) of the OPEC Statistical Bulletin for 1972. The use of this method provides an easy means of providing reasonably accurate revenue information for testing other modules over this time period while explicitly avoiding any attempt to model the structural conditions in effect during that time. Overwhelming changes in country-company relationships have taken place since late 1972, with the result that the contractual structure of that period is not at all relevant for future predictions of oil production and revenues.

Beginning with January, 1973, the second stage of the oil module takes over. This stage is an attempt to model the Saudi-ARAMCO participation contract which came into force at that time. Revenues resulting from the sales of independent and sellback crude are kept distinct from tax and royalty revenues, and the Saudi government's growing control over production capacity, production level, and prices is included in the model. In both the second ("participation") and third ("current") stages, a distinction should be made between technologically constrained parameters (such as the cost of production, or the cost of a daily barrel increase in capacity) and "control" parameters, the value of which is set by actions of the producing-country government (sometimes but not always in negotiation with the other members of OPEC and/or the international majors).

The third stage models the country-company contractual relationships presently in force, and takes effect (in the module) beginning January 1974. In this third stage, the producing country government sets prices and production levels unilaterally, disregards entirely the Teheran, Geneva I, and Geneva II agreements, and determines its own share of participation. As this is written, it appears that this "current" stage is flexible enough to be useful for various alternative scenarios of future choices by the producing country government, and it also appears that there is little reason for the government to change structural relationships very greatly in the near future. The government can get virtually everything it wants by changing "control" parameters under the current arangements.

In the event that still another stage is warranted, either by further action on the part of producing country governments or because the user would like to test a set of hypothetical contractual relationships, such a stage may be written by the user and employed in the oil module. However,

this last course will be rather "messy" for the user until the Project's

Terminal Monitor Program is completed, and thus no discussion will be made

during the remainder of this paper of a user-written stage.

The operation of all three stages of the module may best be explained

through use of an illustrative example. Accordingly, such an example is

developed in the next section.

An Illustrative Run

The module is accessed at present by first logging onto the Ohio State

University IRCC System 370's TSO system. Once logged on, the user should

type either

        userp 'tja010.sysproc'  (cr)

or

        free file(sysproc) (cr)

        alloc file(sysproc)  da('tja010.sysproc') (cr)

The system will reply with

        READY

The user should respond by typing

        $80 (cr)

and then, after the system responds with

        READY

once again, he should type

        runoil (cr)


The "$80" command will set the system's output line width to 80 columns.

The "runoil" command will cause the oil module to begin execution after a

(hopefully) short delay. If the system is serving a large number of time-

sharing users when the "runoil" command is sent, however, the delay could be

as much as a minute or two.

The oil module will begin by prompting the user for the year and month
in which he wishes the simulation to start.  The prompt will appear as follows.
A typical user response is indicated following the colon.

> PTP OIL MODULE VERSION OF   (date)
>
> ENTER STARTING MONTH AND YEAR, FOLLOWED BY A SEMICOLON.
>
> EXAMPLE:   YEAR=1967   MONTH=8;
>
> :
>
> year=1972  month=1; (cr)

Of course, any starting month (1 through 12) is valid for the years 1963
through 1972.  If, however, one wishes to have the module begin using either
the "participation" or the "current" stages, one should enter either

> year=1973  month=1; (cr)

or

> year=1974  month=1; (cr)

respectively.  These two stages presently have default initial values valid
only for January, 1973, and January, 1974 respectively.  Only if the user
is prepared to enter the appropriate initial values for all required variables
for months other than these two should he start the module in months other
than these two.

The module will begin computation with the month and year given it and
cycle monthly until instructed to stop.  No prompting for user input will take
place until the module reaches January 1973 (if it was given a starting month
earlier than that).  Beginning in January 1973 (when the participation stage
becomes effective), the module will prompt each month for user inputs.

The "participation" stage is composed of two subroutines:  the "production"
subroutine and the "participation" subroutine.  Equations for the "production"

subroutine are listed in Appendix I, along with descriptions of variables. This subroutine produces as output the simulated measures of production level, current production capacity, level of proved reserves, and so on. It is meant to represent the relatively fixed "physical" process of oil production.

The "participation" subroutine simulates the dominant characteristics of the participation contractual arrangements in existence between ARAMCO and Saudi Arabia in 1973. It generates as output such things as monthly revenues from independent sales of participation crude, from sellback sales of participation crude, and from tax revenues and royalties. It accepts as control inputs values for posted price, for sellback price, for independent crude sales (as a percentage of total production), and so on. Equations for the "participation" subroutine are listed in Appendix II along with definitions of variables.

Default initial values are provided for the appropriate variables for January, 1973 for both subroutines. Thus if one starts the module at that month, or is prompted when the module reaches that month, and changes no values when given the opportunity for that month, the subroutines will each begin an approximate "replication "of production and revenues in Saudi Arabia for 1973. Taking the default initial values would thus be the "normal" option for the "participation" stage. Later during the year, however, the user will be required to enter control information if he wishes to continue the "replication." The control information which he will be required to enter is much the same as that which was actually provided by the Saudi government to ARAMCO in 1973.

For the purposes of this example let us do this. Assume that the starting year and month were entered as

    year=1973  month=1;  (CR)

The module would then respond by printing

YEAR=1973     MONTH=1;

PRODUCTION SUBROUTINE PROMPT

:

The user's response would be

; (cr)

in order to take the default initial values.  After computations were completed
for production for the current month, the production subroutine would list the
values of all variables computed in the production subroutine equations.

(OUTPUT APPEARS HERE....)

The module would then print

PARTICIPATION SUBROUTINE PROMPT

:

to which we have agreed to respond by typing

; (cr)

Once again the default initial values have been selected.  And, in a manner
identical to that just described for the "production" subroutine, the values
of all variables computed in the "participation" subroutine equation are printed
as output.

(OUTPUT APPEARS HERE...)

The module would next print

CONTROL PROMPT

:

If the user wished the module to continue running, he would enter

; (cr)

If, however, he wishes the module to stop running, he would enter

runswitch='STOP'; (cr)

The basic cycle of the oil module is, then, the following sequence of

prompts and outputs:

      MONTH=         YEAR=    ;

      PRODUCTION SUBROUTINE PROMPT

      :

      (user input, if any) ; (cr)

      (PRODUCTION SUBROUTINE OUTPUT)

      PARTICIPATION SUBROUTINE PROMPT

      :

      (user input, if any) ; (cr)

      (PARTICIPATION SUBROUTINE OUTPUT)

      CONTROL PROMPT

      :

      ; (cr) (or runswitch='STOP'; (cr))

During the module's cycle for the twelfth month of each year, however, yearly aggregate values for some of the variables are printed in each subroutine's output. These yearly totals are clearly identified and thus their format will not be discussed here. Appendix III lists the control inputs which must be entered by the user in order to "replicate" the actual events of 1973.

In January, 1974, the "current" stage begins. What happens inside the module is that the "participation" subroutine is replaced by the "current" subroutine. The same "production" subroutine is used in this stage. The equations and variable definitions for the "current" subroutine are given in Appendix IV. and it may be noticed that many of the variables are identical with those in the "participation" subroutine. There are, however, important differences concerning the increased unilateral control of the producing country in setting the various prices involved.

The prompts that appear for the "current" subroutine are similar to those

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for the "participation" subroutine:

    CURRENT SUBROUTINE PROMPT

    :

It is suggested, of course, that the user accept the default initial values
for the subroutine by responding with

    ; (cr)

to the January, 1974, prompt by the subroutine. Appendix V shows the appropriate
control inputs by the user in order to "replicate" the first four months of
1974 and, in addition, to carry out the proposed ARAMCO capital investment
program to increase capacity to 20M barrels per day by the end of 1980. Output
for the "current" subroutine is similar to that of the "participation" sub-
routine, and includes a similar yearly summary for some variables.

## Summary

The descriptions and instructions in earlier sections, when combined with
the information in the various Appendices, should provide the reader with a
reasonably clear understanding of how to run the oil module in its present
stand-alone form. As mentioned earlier, the user module communication interface
is temporary in the sense that it will be replaced when the module is joined
with others in the near future. Nonetheless, the module as presently running
provides a means of testing future alternative scenarios. Furthermore, to the
extent that the control inputs necessary to have the module "replicate" recent
history have been identified we have a basis for attempting to construct parts
of the decision module; it should provide something close to these control inputs
when presented with a similar context.

It was hoped that a printout from the sample run suggested in this report
would be available. However, last minute computer problems prevented the inclu-
sion of such a printout in this report.

# APPENDIX I

## Production Subroutine Equations,
## Variable Descriptions, and Initial Values

EQUATIONS:

$$IR = (DPIR)(COCI)$$

where:

|  |  |
|---|---|
| IR $ | Investment Rate: the amount of capital to be invested in order to achieve a given increase in production capacity ADBR months later. |
| DPIR bbl/da | Desired Production Increase Rate: the number of bbl/da production capacity is to be increased ADBR months later. |
| COCI $/bbl/da | Cost of Capacity Increase: · average overall cost of an increase of 1 bbl/da in production capacity. |

$$PC = PC + EI$$

where:

|  |  |
|---|---|
| PC bbl/da | Production Capacity: average daily production capacity for current month. |
| EI bbl/da | Effective Investment: the increase in production capacity which is to become operational during the current month (ADBR months after the money was committed for its purchase). |

$$P = (PAPC)(PC)$$

where:

|  |  |
|---|---|
| PAPC dimensionless range: 0.00 to 1.00 | Production as Percent of Capacity: the level of production desired by government decision-makers |

expressed as a proportion of the present month's capacity.

P   bbl/da         Production Rate: average actual production per day during the current month.

$$MP=(DAYS)(P)$$

where:

MP   bbl         Monthly Production: actual production for the current month.

DAYS da         Number of days in the current month.

$$PR=(PRM)(MP)+PR$$

where:

PR   bbl         Proved Reserves: current estimate of oil-in-place which can be recovered with existing facilities and technology and at current costs of production.

PRM   dimensionless         Proved Reserves Multiplier: average ratio of net increase in proved reserves to monthly production for a given month.

ESTIMATES OR PARAMETER AND VARIABLE INITIAL VALUES FOR JANUARY 1973:

ADBR = 3 months

COCI = $300/bbl/da

DPIR = 219,000     bbl/da

PAPC = 1.0

PC   = 6,575,000   bbl/da

PRM = 1.43

PR   = 92,992,000  bbl

# APPENDIX II

## "Participation" Subroutine Equations,
## Variable Descriptions, and Initial Values

The following block of equations adjusts posted price according to the second Geneva agreement, and is used for the months of June through December 1973.

```
IF MONTH = 6 THEN BEGIN:

        IF MONTH = 6 THEN PP=2.898

        TESTCUR=(THISCUR-LASTCUR)/100

        IF TESTCUR>=.01 THEN CF=TESTCUR

            ELSE CF=0

        LASTCUR=THISCUR

        PP=PP+(TPOST)(CF)

    END;
```

where

| | | |
|---|---|---|
| TESTCUR | dimensionless | the percentage increase or decrease in the value of THISCUR (as measured on the 23rd of the previous month) compared with LASTCUR, the value of THISCUR _from the previous iteration_. |
| THISCUR | $ | the average value of a designated group of currencies as determined on the 23rd of the previous month. |
| CF | dimensionless | Currency Factor: the proportion of inflation or deflation of the designated group of currencies referred to in THISCUR. |

| TPOST | $ | | The value for PP that would be in effect during a given month under the terms of the Teheran Agreement but excluding the terms of the first and second Geneva Agreements. |
| PP | $ | | Posted Price: the artificial price used in country - company relationships as a basis for determining (for tax purposes only) company "profits". |

For the months January through May, the following simple assignments of posted prices which resulted from application of the Second Geneva Agreement are made:

IF MONTH=1 THEN PP=2.594

IF MONTH=5 THEN PP=2.742

For all months in 1973, the following participation equations are used to determine revenues:

$$\text{TAXPAID}=(\text{PP}-\text{COP}-(\text{ROYALTY})(\text{PP}))(\text{TAXRATE})+(\text{ROYALTY})(\text{PP})$$

where

| TAXPAID | $/bbl | | Tax Paid Price: the price (less production costs) paid by oil companies for their share of the oil produced. |
| COP | $/bbl | | Cost of Production: average cost of producing one bbl of crude oil and delivering it to a tanker loading facility. |
| ROYALTY | dimensionless | | The fixed proportion of posted price which is paid, on each company owned barrel, as a royalty to the producing-country government. |
| TAXRATE | dimensionless | | The proportion of company "profit" (on each barrel of crude oil) which is owed to the |

producing country government as a tax.

TR=(TAXPAID)(MP)(1-SHARE)

where

TR    $   Tax Revenue:  the sum of all royalties and
taxes paid to the producing country govern-
ment for the current month's production.

SHARE    dimensionless   the ownership share (proportion) held by
the producing country government under the
terms of a participation agreement.

INDCRUD=(CRUDPCT)(MP)

where

CRUDPCT    dimensionless   Ratio of that portion of the current month's
production which is owed by the producing
country government, and which is to be sold
independently by the government, to the
current month's production.

INDCRUD    bbl   The amount (of the current month's produc-
tion) which will be sold independently by
the producing country government.

SELBACP=SELBACC(PP-TAXPAID)+TAXPAID

WHERE

SELBACP    $/bbl   Sell Back Price:  the price at which
participation oil not sold independently
by the government is sold back to the
companies.

SELBACC    dimensionless   The proportion of the difference between
taxpaid cost and posted price that is added

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to taxpaid cost in order to arrive at the sellback price.

SELBAC=(SELBACP)((SHARE)(MP)-INDCRUD)

where

| | | |
|---|---|---|
| SELBAC | $ | Revenue received by the producing country government as a result of sales of its share of crude oil production by the oil companies through their regular channels. Such oil is said to be "sold back" to the companies. |

INDSALE=(INCRUD)((INDPCT)(PP)-COP)

where

| | | |
|---|---|---|
| INDSALE | $ | Net revenue received by the producing country government from its _independent_ sales of crude oil. |
| INDPCT | dimensionless | Ratio of the price at which independent sales of crude oil are made (by the producing country government) to the posted price. |

CR=INDSALE+SELBAC

where

| | | |
|---|---|---|
| CR | $ | Crude Revenue: total revenue accruing to a producing country government through sales of crude oil it owns as a result of participation contracts. |

INITIAL VALUES for parameters and variables in January 1973.

| | | | |
|---|---|---|---|
| PP | = | 2.594 | $/bbl |
| COP | = | .10 | $/bbl |
| ROYALTY | = | .125 | |
| TAXRATE | = | .55 | |
| SHARE | = | .25 | |
| CRUDPCT | = | .025 | |
| SELBACC | = | .810 | |
| INDPCT | = | 1.0 | |
| THISCUR | = | 100 | |
| TPOST | = | 2.392 | |
| LASTCUR | = | 100 | |

# APPENDIX III

## Control Inputs to "Replicate" Actual Production for 1973

| MONTH | INPUTS |
|-------|--------|
| 1 | none |
| 2 | none |
| 3 | none |
| 4 | none |
| 5 | none |
| 6 | none |
| 7 | THIS=102.899 |
| 8 | THISCUR=105.716 |
| 9 | THISCUR=103.922 |
| 10 | PP=4.126 |
| | DPIR=0 |
| | PAPC=.9074 |
| 11 | PP=5.176 |
| | PAPC=.6784 |
| 12 | PAPC=.7165 |

## APPENDIX IV

### "Current" Subroutine Equations,
### Variable Descriptions, and Initial Values

In the following equations, all variables not explicitly described are
identical to the variables with the same names defined in Appendix II.

$$TAXPAID=(PP-COP-(ROYALTY-ROYCRUD)(PP))(TAXRATE)+(ROYALTY-ROYCRUD)(PP)$$

where

| ROYCRUD | dimensionless | The proportion (which can never exceed ROYALTY) of the companies' share of production which the producing country government chooses to take in the form of oil instead of royalty payments. |
|---------|---------------|---|

$$TR=(TAXPAID)(MP)(1-SHARE-(ROYCRUD)(1-SHARE))$$

$$INDCRUD=[CRUDPCT+(1-BACKROY)(ROYCRUD)(1-SHARE)](MP)$$

$$SELBACP=(BACPCT)(PP)$$

where

| BACPCT | dimensionless | proportion of posted price at which sell-back transactions take place. |
|--------|---------------|---|
| BACKROY | dimensionless | proportion of royalty crude to be sold back to companies. |

$$SELBAC=(SELBACP)[(SHARE+(BACKROY)(ROYCRUD)(1-SHARE))(MP)-INCRUD-(DOMUSE)(DAYS)]$$

where

| DOMUSE | bbl/da | Domestic Usage: amount of crude oil required for daily domestic consumption during the current month. |
|--------|--------|---|

$$INDSALE=(INDCRUD)((INDPCT)(PP)-COP)$$

$$CR=INDSALE+SELBAC$$

Initial values for "current" subroutine parameters and variables for January 1974:

| | | | |
|---|---|---|---|
| PP | = | 11.651 | $/bbl |
| COP | = | .10 | $/bbl |
| ROYALTY | = | .125 | |
| ROYCRUD | = | 0 | |
| TAXRATE | = | .55 | |
| SHARE | = | .25 | |
| CRUDPCT | = | .025 | |
| BACPCT | = | .93 | |
| DOMUSE | = | 60000 | bbl/da |
| INDPCT | = | .93 | |
| BACKROY | = | 0 | |

# APPENDIX V

## Control Inputs to "Replicate" Actual Production for 1974

| Month | INPUTS |
|-------|--------|
| 1 | DPIR=95000 |
|   | PAPC=.8136 |
| 2 | PAPC=.8439 |
| 3 | PAPC=.8803 |
| 4 | PAPC=.9302 |
| 5 | none |
| 6 | none |
| 7 | ROYALTY=.145 |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |

NOTE:  In order to simulate carrying out the proposed ARAMCO capital

investment program,

set DPIR=147200 in OCT 75

and DPIR=0 in OCT 1980